Information Flows and HRM Practices in R&D Organization: A Comparative Study of the Japanese Pharmaceutical and Electronics Industries.

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Introduction

There has been growing interest in the international comparisons of work organization and employment practices. According to the contingency theory, the efficiency of different modes of organizing depends on environmental factors such as markets and technologies.

However, Aoki[1988] states that, irrespective of their environments, typical Japanese firms employ decentralized information structures and centralized/organization-oriented personnel administrations. In contrast, typical American firms adopt centralized information structures and decentralized/market-oriented personnel administrations.

Aoki[1989] also argues that such differences in organizational structure result in differences in the competitive advantages of industries in respective countries. The typical Japanese organization may be more efficient in a highly competitive market environment in which demand fluctuates continuously, but not drastically. On the other hand, the American organization may be more efficient in a market in which demand is either very stable or changes drastically. As for the ability to innovate, Japanese firms show great strength in incremental process improvements, but are not as strong in completely new conceptual or scientific developments.

Likewise, Okimoto & Nishi[1994] argue that Japanese semiconductor manufacturers have performed well in the market for DRAM, SRAM, and discrete devices where the technological trajectories are predictable, the theoretical parameters are well defined, and the transfer of technology from prototype to mass manufacturing requires extensive interaction and communications. However, they also state that the organization of Japanese R&D is not designed to encourage bold new conceptualizing, radical departure from the prevailing orthodoxy, and free-wheeling exploration of territories unmapped by known theories.

The first goal of this paper is to examine whether there are any differences between the pharmaceutical and electronics industries in Japan in terms of the information structure and human resource management practices such as recruitment, the development of skills and abilities, remuneration and rewards. It is generally accepted that basic/applied research is the key to the success of the pharmaceutical industry and the Japanese pharmaceutical firms have not been successful in international markets(1). In contrast, the electronics industry manufactures and markets internationally highly competitive products such as computers, communication equipment, VTRs, and color televisions. Thus, it should be interesting to study the factors behind the performance difference between these industries; focusing especially on the information structure and human resource management practices of scientists and engineers.

We also analyze the complementarities among information flows and elements of human resource management practices in both industries. Milgrom & Roberts[1995] suggest how the elements of optimal firm strategy, structure and process are linked to one another and how they would change in a coherent fashion in a changing environment. Aoki & Okuno[1996] analyze the complementarities among 'seniority-based wage and promotion systems', 'lifetime employment' and 'firm specific skill', which are peculiar components of the employment practices in Japanese firms.

In terms of empirical studies, Ichiniowski, Shaw and Prennushi[1995] analyzed data obtained through personal visits to 26 steel plants and found that the adoption of a coherent system of new work practices including work teams, flexible job assignments, employment security, training in multiple jobs and extensive reliance on incentive pay, produced substantially higher levels of productivity than did more 'traditional' approaches involving narrow job definitions, strict work rules, and hourly pay with close supervision. However, the use of individual work practice innovations in isolation has no effect on productivity, showing the importance of complementarities among a firm's work practices. Thus, the second purpose of the paper is to examine whether features of information flows and elements of human resource management practices are complementary in R&D organizations in both industries and whether different types of complementarities are observed.

The data which we analyzed had been collected by means of a survey targeting scientists and engineers in Japanese private enterprises(2). A total of 1,600 questionnaires were sent out to researchers in 14 R&D organizations and 1,353 effective responses were collected from November 1997 to February 1998. The response rate for the questionnaires was quite high and reached 84.6 percent. To identify the elements which would stimulate and encourage researchers to produce original and creative research, the questionnaire survey covered a wide range of questions: recruitment, intrafirm personnel transfer, the development of skills and abilities, dual ladder system remuneration and reward, motivation and satisfaction, creativity and research achievement, information flows, etc. In this study, we analyzed 1034 responses from seven pharmaceutical companies and two electronics companies.

1 Information Flows

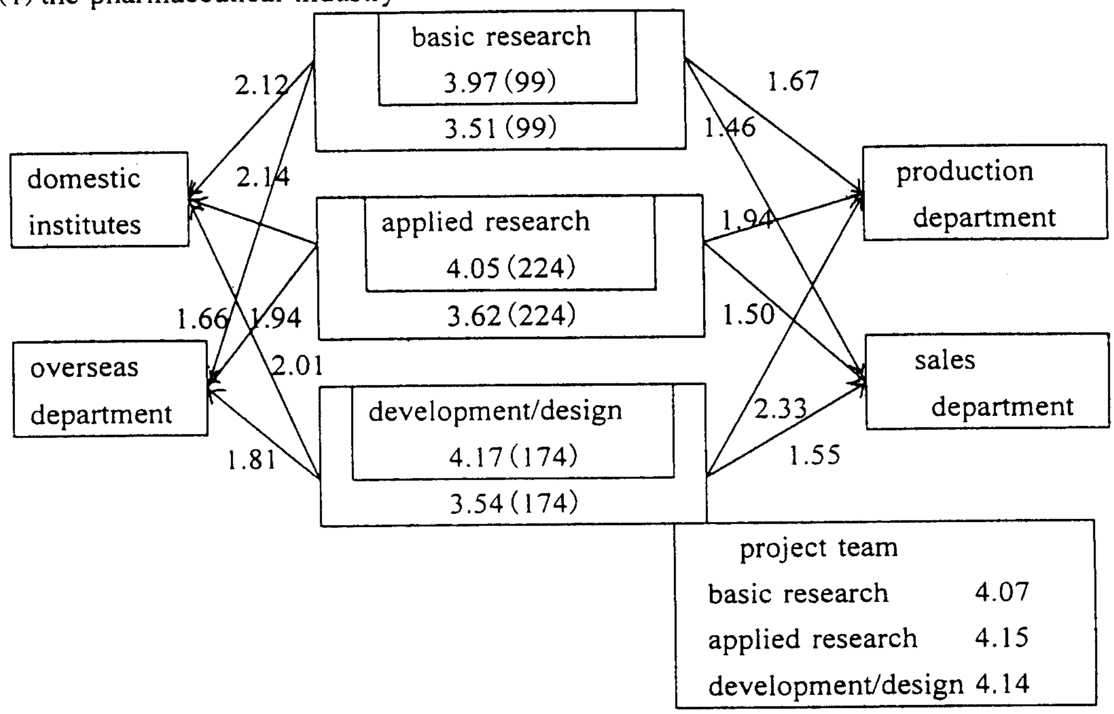
In the survey, the respondents were asked to rate how often they consult and discuss with members or researchers about their R&D activities. We used a five-point consecutive scoring scale, from 1 to 5, in which 1 = 'never' and 5 = 'always'. Figure 1 shows the results from three major departments: the basic research; the applied research; and the product development/design. The values on the lines represent the average frequency of communication between the two departments. The figures in the inside square, in the outside square, and on the squares labeled 'project team' reveal respectively the communication frequency within the same department, the research institute, and the project team.

It is interesting to note that the figures above 3 are communications within the same department, the same research institute and the same project team for both industries. However, communication with researchers outside the company, members of the sales and the production departments is quite rare. This shows that the range of information flows are extremely limited. Figure 1 also illustrates the differences of the information flows by industry. It is noticeable that the frequencies of information flows within a department and within a research institute are higher in the pharmaceutical industry than in the electronics industry in both the applied research and the product development/design departments. However, the frequency within the project team is higher in the latter than in the former for both departments.

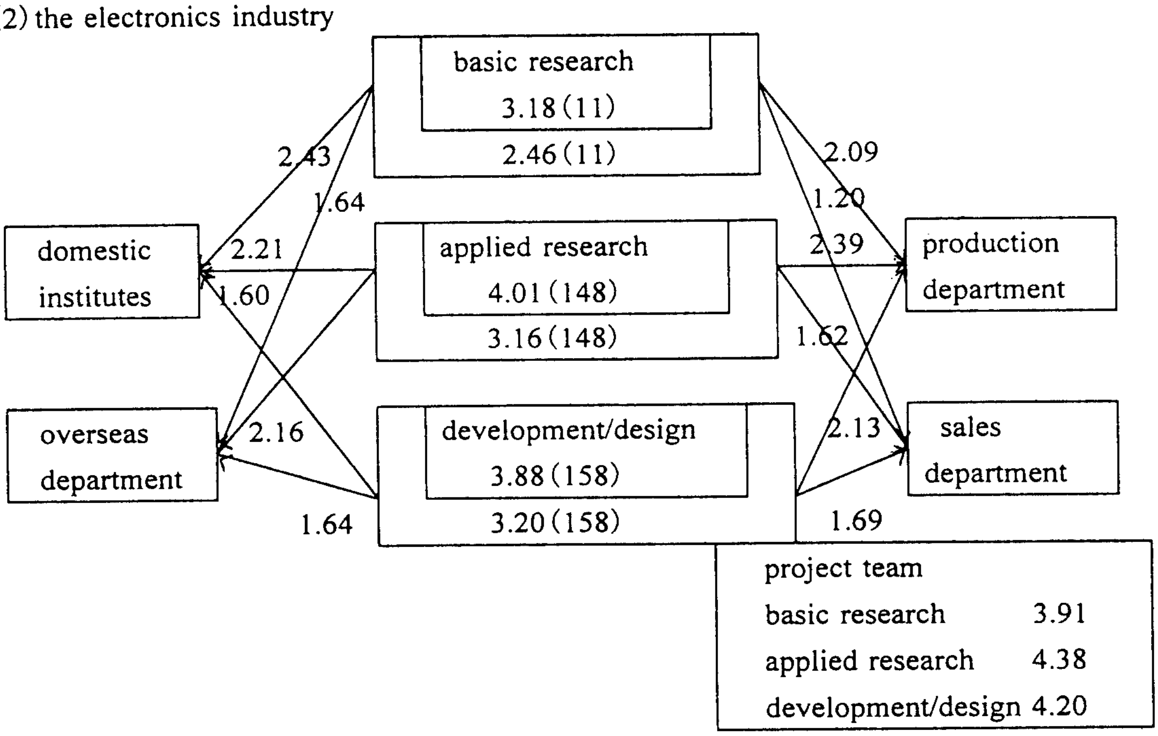
In addition, the respondents were asked to rate the statements about management practices from 1 to 5, in which 1 = 'not at all' and 5 = 'always'. Table 1 shows the average scores for each statement. The two statements that 'R&D staffs are provided with information on the market and customers' and 'project teams are used extensively to meet changing research needs' have significantly higher means in the electronics industry than in the pharmaceutical industry, while two other statements 'there are many opportunities to exchange research information by inviting researchers within the company and from other firms' and 'research exchange is promoted with other research institutes, professional

Figure 1 Information flows

(1) the pharmaceutical industry



(2) the electronics industry



Note
1 The figures in parenthesis show the number of samples.

Table 1 The mean value of a five-point consecutive scoring scale for each statement in management practices

statement	pharmaceutical industry	electronics industry	t-value
1 R&D is closely linked to the commercalization of products.	3.66 (1.04)	3.67 (1.02)	−0.13
2 R&D staff are provided with information on the market and customers.	2.53 (0.93)	2.71 (1.03)	−2.66***
3 Contributions of individuals are fairly evaluated even when work is done as a team.	2.88 (0.92)	2.99 (0.88)	−1.89*
4 There are many opportunities to exchange reseach information by inviting researchers within the company and from other firms.	3.11 (0.93)	2.80 (0.98)	4.76***
5 Research exchange is promoted with other research institutes, professional societies and universities.	3.20 (0.91)	2.95 (1.01)	3.66***
6 Many reseachers from other research insitutes and universities are recruited.	2.53 (0.96)	2.49 (1.01)	0.65
7 Researchers have grest freedom over expenditures and the management of staff at the research institute.	2.80 (0.97)	3.12 (0.95)	−4.91***
8 Researchers make independent decisions over the management of working hours.	4.01 (0.80)	4.05 (0.84)	−0.78
9 The research theme is assigned in consideration of what individual researchers are interested in.	2.39 (0.94)	2.74 (0.93)	−5.52***
10 Project teams are used extensively to meet changing research needs.	3.15 (0.88)	3.33 (0.85)	−3.01***

Note
1 The figures in parenthesis are the standard deviations.
2 $*p<0.1$ $**p<0.05$ $***p<0.01$

societies and universities' are significantly higher in the pharmaceutical industry.

It can be said from these findings that greater specialization is demanded of R&D workers in the pharmaceutical industry. They, therefore, communicate more often with other researchers engaging in the same research field within the company and from other firms. In the electronics industry, information concerning manufacturing, sales and markets is also important for R&D workers and a project team may serve as a good opportunity for information exchange.

2 Recruitment

The number of the respondents with previous employment experience in the pharmaceutical industry is 28, accounting for 5.0% of the total sample of 561. For the electronics industry, it is 40, accounting for 11.7% of the total sample of 341. Consequently, the proportion of the sample with previous employment experience is higher in the electronics industry than in the pharmaceutical industry. However, the vast majority of researchers stay in the same company in both industries. It is also shown in the Table 1 where the scores of the statement 'many researchers from other research institutes and universities are recruited' are low, 2.53 for the pharmaceutical industry and 2.49 for the electronics industry.

The channels through which the respondents have been recruited are shown in Table 2. It is noteworthy that over fifty percent of respondents in the pharmaceutical industry are recruited through an introduction by university professor. In the electronics industry, each of the three channels, 'introduction by university professor', 'introduction by university placement office', and 'applied directly to the company' accounts for about twenty percent. Although there is a difference by industry, in both industries, the channels associated with universities such as 'introduction by professor', 'introduction by university alumni' and 'introduction by university placement office' play an important role for securing employment, the total of which is over sixty percent of the whole respondents.

Table 2 Channels of Recruitment

channels	pharmaceutical industry	electronics industry
introduction by university professor	55.6 %	22.2 %
introduction by university alumni	5.4	13.9
introduction by university placement office	6.1	24.3
introduction by parents, relatives or friends	8.4	3.3
applied directly the company	10.9	18.9
responded to prospectus or advertisement of the company	7.5	10.1
was approached directly by the company	3.1	0.6
introduction by employment agency	0.7	3.3
others	2.3	3.6
total	100.0	100.0

3 Methods of Skill and Ability Development

In this section, we will analyze the methods of developing the researchers' skills and abilities. As shown in Table 3, the R&D workers selected the three most common skill development methods out of 15. The first choice, the second choice, and the third choice were scored 3, 2, 1, respectively. The average score and standard deviation were determined for each item. We can see that the skill

Table 3 The average score for each method of skill development

methods	applied research			development/design		
	P	*E*	*t*-value	*P*	*E*	*t*-value
1 guidance by supervisors/seniors in on-the-job training	2.29 (1.19)	2.05 (1.30)	1.83*	2.16 (1.26)	2.03 (1.27)	0.96
2 experience in highly responsible work	0.67 (1.00)	0.84 (1.08)	−1.64	0.73 (1.06)	0.84 (1.12)	−0.94
3 extensive rotation within the R&D department	0.25 (0.67)	0.14 (0.50)	1.88*	0.39 (0.78)	0.35 (0.78)	0.45
4 transfer to operating departments	0.10 (0.42)	0.07 (0.34)	0.89	0.25 (0.69)	0.12 (0.43)	2.06**
5 Participation in joint projects with researchers from different fields	0.07 (0.37)	0.24 (0.63)	−2.97***	0.03 (0.24)	0.23 (0.66)	−3.43***
6 planning and implementing new projects	0.23 (0.69)	0.49 (0.98)	−2.82***	0.22 (0.63)	0.44 (0.84)	−2.57***
7 temporary assignment in an affiliated company	0.02 (0.19)	0.01 (0.16)	0.23	0.01 (0.08)	0.04 (0.30)	−1.34
8 participation in joint projects in other research institutes	0.13 (0.43)	0.08 (0.36)	1.07	0.09 (0.41)	0.07 (0.32)	0.51
9 post-hire study in domestic universities	0.17 (0.49)	0.01 (0.08)	4.87***	0.21 (0.60)	0.01 (0.08)	4.36***
10 post-hire study in foreign universities	0.22 (0.62)	0.17 (0.49)	0.95	0.16 (0.50)	0.05 (0.30)	2.30**
11 self-development	0.56 (0.89)	0.65 (1.02)	−0.90	0.70 (1.06)	0.86 (1.10)	−1.35
12 lectures/seminars in your professional field	0.42 (0.83)	0.39 (0.78)	0.27	0.51 (0.81)	0.61 (0.90)	−1.08
13 participation in exchanges and study groups with specialists from other companies	0.09 (0.40)	0.11 (0.39)	−0.45	0.03 (0.25)	0.05 (0.25)	−0.85
14 participation in study groups inside the company	0.04 (0.28)	0.05 (0.28)	−0.32	0.02 (0.23)	0.05 (0.30)	−1.18
15 attending academic meetings and conferences in your field	0.68 (0.92)	0.68 (0.93)	−0.03	0.49 (0.75)	0.19 (0.57)	4.16***

Note

1 P and E stand for respectively the pharmaceutical industry and the electronics industry.

2 The numbers of samples are: 224 for the applied research in the pharmaceutical industry; 174 for the product development/design in the pharmaceutical industry; 148 for the applied research in the electronics industry; and 153 for the product development/design in the electronics industry.

3 The figures in parenthesis are standard deviations.

4 $*p<0.1$ $**p<0.05$ $***p<0.01$

development methods with the top three average scores are almost identical in both industries. Here the top threes are 'guidance by supervisors/seniors in on-the-job training', 'experience in highly responsible work', and 'attending academic meetings and conferences in your field' for the applied research, and the top two are the same, but the third is 'self-development' for the development/design.

However, differences by industry are also observable. As for the applied research department, there are three items whose means are significantly higher in the pharmaceutical industry than in the electronics industry, as indicated by the t- tests. The three items are 'guidance by supervisors/seniors in on-the job training', 'extensive rotation within the R&D department' 'post-hire study in domestic universities'. Therefore, on-the-job training conducted within a department and a research institute, and the methods for enhancing researchers' specialization outside the firms are emphasized in the pharmaceutical industry. This seems to be consistent with the findings that communication within a department and within a research institute, and with experts outside the company are more often observed in that industry. On the other hand, the items with significantly higher scores in the electronics industry are 'participation in joint projects with researchers from different fields' and 'planning and implementing new projects', both of which are associated with projects. It is consistent with the findings discussed above that communication within a project team is more often important in the electronics industry.

Regarding the product development/design department, the methods with significantly higher scores in the pharmaceutical industry are 'transfer over department', 'post-higher study in domestic universities', 'post-hire study in foreign universities', and 'attending academic meetings and conferences in your field'. The last three methods seem to be related to the trend that information exchange with researchers who belong to other institutes and work in the same research field is observed more often in the pharmaceutical industry. It is, therefore, inferred that R&D workers receive more encouragement to develop their academic specialization in both the applied research and the product development/design departments in the pharmaceutical industry. On the other hand, the skill development methods with significantly higher scores in the electronics industry are the same as those in the applied research; they are more associated with a project team.

4 Remuneration and Rewards

In this section, we will focus on how companies reward researchers who have made substantial achievements in research. Fourteen reward forms (see Table 4) were given to respondents to select and place in the order of how frequently they are used in their companies. The first, the second, and the third choices were scored respectively 3, 2, 1, then the average score and standard deviation were determined for each of the items. In both industries, 'bonus and individual rewards', 'pay raise', 'intracompany commendation' and 'promotion to managerial posts' are major forms of remuneration and rewards, irrespective of the departments to which they belong. They are probably the most common methods of rewarding employees in Japanese enterprises.

Table 4 The average score for each form of remuneration and rewards

forms of remuneration and rewards	applied research			development/design		
	P	*E*	*t*-value	*P*	*E*	*t*-value
1 pay raise	1.15 (1.32)	0.91 (1.15)	1.80*	1.18 (1.31)	0.74 (1.15)	3.26***
2 bonus and individual rewards	1.07 (1.23)	2.38 (1.06)	−10.67***	1.13 (1.21)	0.84 (1.22)	2.17**
3 sabbatical leave	0.01 (0.20)	0.02 (0.18)	−0.32	0.03 (0.27)	0.00 (0.00)	1.39
4 long vacation	0.00 (0.00)	0.03 (0.26)	−1.27	0.01 (0.08)	0.00 (0.00)	0.96
5 promotion to managerial posts	0.89 (1.07)	0.83 (0.89)	0.60	0.88 (1.10)	1.18 (1.24)	−2.35**
6 appointment to special status research specialist positions(e.g., fellow)	0.49 (0.95)	0.17 (0.57)	4.16***	0.26 (0.69)	0.30 (0.79)	−0.42
7 greater freedom in setting research themes and how to proceed	0.27 (0.71)	0.21 (0.66)	0.90	0.30 (0.78)	0.50 (0.94)	−2.15**
8 greater delegation of authority over research activities	0.12 (0.44)	0.20 (0.60)	−1.31	0.16 (0.54)	0.28 (0.70)	−1.81*
9 larger research budget	0.10 (0.48)	0.28 (0.67)	−2.77***	0.10 (0.51)	0.44 (0.87)	−4.29***
10 more research staff	0.13 (0.51)	0.19 (0.52)	−0.96	0.08 (0.38)	0.33 (0.71)	−3.94***
11 outside research opportunities (e.g., study in university)	0.41 (0.81)	0.13 (0.44)	4.27***	0.45 (0.86)	0.05 (0.27)	5.83***
12 intracompany commendation	1.05 (1.21)	0.56 (0.88)	4.56***	1.14 (1.19)	0.84 (1.13)	2.31**
13 acquisition of patent	0.04 (0.26)	0.00 (0.00)	2.53**	0.09 (0.39)	0.13 (0.54)	−0.74

Note

1 See the note of table 3.

Table 4 also reveals differences by industry. The two forms 'bonus and individual rewards' and 'larger research budget' are significantly higher in the applied research department of the electronics industry than in that of the pharmaceutical industry. In the case of the product development/design department, 'promotion to managerial posts', 'greater freedom in setting research themes and how to proceed', 'greater delegation of authority over research activities', 'larger research budget' and 'more research staff' are significantly higher in the electronics industry. Therefore, it can be said that freedom and discretion in a team are more emphasized for remuneration and rewards in the electronics industry. This is consistent with the findings that communication within a project team and the methods of developing skills and abilities in a project team are more often observed in the electronics industry.

This feature is also revealed in Table 1 where the following three statements have significantly higher scores in the electronics industry: 'researchers have great freedom over expenditures and the management of staff at the research institute', 'the research theme is assigned in consideration of what individual researchers are interested in' and 'contributions of individuals are fairly evaluated even when work is done as a team' Therefore, it is inferred that the electronics industry has a system to reward researchers such that they have more freedom in their activities in a project team based on their achievements.

The items which have significantly higher scores in the pharmaceutical industry are 'pay raise', 'appointment to special status research specialist positions(e.g., fellow)', 'outside research opportunities', 'intracompany commendation' and 'acquisition of patent' in the applied research department, whilst for the product development/design department, they are 'pay raise', 'bonus and individual rewards' ,'outside research opportunities' and 'intracompay commendation', most of which are individual incentive. As discussed above, in this industry there is more communication with researchers who work in the same department or who belong to other research institutes and work in the same research field than in the electronics industry. In addition, the methods of skill development in this industry focus on enhancing the academic knowledge and specialization of individual researcher. Therefore, one can say that the remuneration and rewards are also designed to fit the information flows and the methods of skill development.

5 Income and Position

In general we can anticipate that the higher the level of achievements of the respondents, the higher the income and status position they attain. In order to examine this hypothesis, the following income function and position function are estimated. As far as the income function is concerned, the dependent variable is a logarithm of annual income before tax, and dependent variables are age, educational level, and achievements. The independent variable of achievement is the total number of times each respondent has accomplished in all the 13 areas of achievement shown in table 5. The variable of educational level is composed of three consecutive levels, where 1 = 'doctorate', 2 = 'master's degree', 3 = 'college degree'. Age at the time of the survey is used as the age variable. As for the position function, the dependent variable is the position ranked 1 = 'director or equivalent', 2 = 'general manager or equivalent', 3 = 'assistant general manager or equivalent', 4 = 'section chief or equivalent', 5 = 'sub-section chief or equivalent', and all of the independent variables are same as those of the income function.

Table 5 Type of achievements

1	Overseas patent application
2	Domestic patent application
3	Research presentaion at an overseas academic meeting
4	Research presentation at a domestic academic meeting
5	Publication of a paper in a foreign journal
6	Publication of a paper in a domestic journal
7	Commercialization of research achievements
8	Commendation won in the company for research achievements
9	Commendation won outside of the company for research
10	Satisfied important demands from operating divisions
11	Lecture as an invited guest
12	Chaired a session in an international conference
13	Organaized an international conference

The results are shown in table 6. Regarding the income function, the age variable and the achievement variable are significantly positive and the variable of educational level is significantly negative in both industries. Therefore, there is a common trend in both industries that the higher the respondents' age or educational level or achievement level, the higher their income is. It would be worth mentioning that although Japanese firms are well known for their seniority wage system, degrees and recent achievements are also determinant factors of income.

Next, the position functions in both industries show significantly negative effect of the age variable and significantly positive effect of the educational level, which reveals that researchers with higher age or with higher educational level are in the higher position of corporate hierarchy. In addition, the achievement variable is significantly negative in the pharmaceutical industry, but not in the electronics one, which shows that the respondents with more achievements are not necessarily in the higher position in the latter industry. It may be due to the fact that the achievements asked by our questionnaire may not measure appropriately the achievements accomplished by an individual researcher . However, there may be another possibility in that the electronics industry requires employees with higher positions to have management ability which can not be evaluated by the number of papers, patent applications etc.

Table 6 Regression Analysis of Income and Position

variable	pharmaceutical industry		electronics industry	
	position	income	position	income
age	−0.10*** (−30.18)	0.04*** (34.14)	−0.15*** (−22.31)	0.04*** (25.81)
educational level	0.19*** (4.65)	−0.07*** (−4.74)	0.25*** (4.42)	−0.03** (−2.32)
achievement	−0.009** (−2.23)	0.005*** (3.03)	0.000 (0.05)	0.002*** (3.56)
constant	7.41*** (53.96)	5.23*** (104.85)	8.89*** (32.91)	5.12*** (76.41)
N	461	461	288	288
R^2	0.69	0.74	0.66	0.73

Note
1 The data were for the researchers whose average actual working hours exceed 35 hours per week.
2 Figures in parenthesis are t-values.
3 $^{**}p<0.5$ $^{***}p<0.01$

Conclusion

This study focused on the differences in information flows and human resource management practices such as recruitment, the development of skills and abilities, and remuneration and rewards between the pharmaceutical and the electronics industries, targeting R&D workers. In the pharmaceutical industry, there is more frequent communication within a department, within a research institute, and with specialists outside the company. This is consistent with the findings that OJT, rotation within the R&D department, post-hire study in both domestic and foreign universities, and attending academic conferences are more emphasized as methods for developing skills and abilities. It is inferred from these findings that work is more specialized and researchers are trained to enhance their expertise in their research field. Furthermore, in comparison with the electronic industry, there is more emphasis placed on pay raise, appointments to research fellows, outside research opportunities, and personal acquisition of patents, as means of remuneration and reward. This also seems to be designed to serve as individual incentives to enhance a researcher's expertise and academic knowledge. In fact, our regression analysis showed that researchers with more achievements are in the higher positions of corporate hierarchy and earn more annual income.

Conversely, there is more frequent communication within a project team in the electronics industry. The methods for developing skills and abilities which are associated with a project team are more often used in the industry: participation in joint projects with researchers from different fields, and planning and implementing new projects. These features in communication patterns and the methods for developing skills and abilities may fit forms of remuneration and rewards associated with a project team. This would include more research staff, larger research budget, and greater freedom in setting research themes and how to proceed. In addition, there is another interesting feature of this industry in that the number of achievements such as patent applications, papers, and research presentations is not a determinant of promotion. This is probably because management abilities which are not evaluated by those achievements are more highly valued for promotion.

Therefore, there are differences between the two industries in the patterns of information flows, methods for developing skills and abilities, and forms of remuneration and rewards. In addition, the observed features with these practices seem to be complementary and fit well together in each industry. In other words, the two different types of complementarities among HRM practicies and the information flows are seen as depending on each industry's environments. The HRM practicies and the information flows which are devised to promote research activities are to be found in the pharmaceutical industry where basic/applied research plays a major role in market success. In contrast, those in the electronics industry are designed to be suitable for the success in product development/design which brings with it international competitiveness.

However, there are several features which are common to both industries. The central methods of skill development are OJT, experience in highly responsible work, self-development, and lectures/seminars. The most emphasized rewards for substantial achievements are pay raise, bonus and individual rewards, promotion to managerial positions and intracompany commendation. Therefore, the differences between Japanese industries shown in this paper may be small when compared with the differences among Japan and western countries. Further international comparative studies on HRM practices for R&D workers seem to be needed in order to clarify this point.

Note

(1) This research was supported by grants from the Ministry of Education, Science, Sports and Culture and Keio University. This research is a part of the international projects, purpose of which is to compare the career development and management of researchers among some ten countries worldwide.

(2) See, Nihon Kogyo Ginko Sangyo Chosabu[1997]. In our questionnaire survey discussed below, researchers in the electronics industry have accomplished more achievements than those in the pharmaceutical industry.

Reference

Aoki, Masahiko (1988). Information, Incentives, and Bargaining in the Japanese Economy, Cambridge University Press.

____________ (1989). Nihon Kigyo no Sosiki to Jyoho, Toyo Keizai Sinposya

____________ (1994) "The Japanese Firm as a System of Attributes: A Survey and Research Agenda" in Aoki M. and Dore R. D. eds., The Japanese Firm: Source of Competitive Strength, Oxford University Press.

Aoki, Masahiko, and Okuno, Masahiro(1996). Keizai Sisutemu no Hikaku Seido Bunseki, Tokyo Daigaku Syuppankai.

Ishida, Hideo(1998)." Human Resource Management of Scientists and Engineers in Japanese Companies", Keio Studies on Organizational Behavior and Human Performance, No.28.

Kusunoki, Ken and Numagami, Tsuyoshi, "Interfunctional Transfer of Engineers in a Japanese Firm: An Empirical Study on Frequency, Timing, and Pattern", Keio Business Forum, Vol.13, No.3.

Milgrom, Paul and Roberts, John(1995)."Complementarities and Fit Strategy, Structure, and Organizational Change in Manufacturing", Journal of Accounting and Economics, 19.

Nihon Kogyo Ginko Sangyo Chosabu(1997). Nihon Sangyo Dokuhon, Toyo Keizai Shinposya.

Okimoto, Daniel and Nishi Yoshio(1994). "R&D Organizaiton in Japanese and American Semiconductor Firm" in Aoki, M. and Dore, R. D. eds., The Japanese Firm: Source of Competitive Strength, Oxford University Press.

Ichniowski, Casey, Shaw, Kathryn and Prennushi, Giovanna(1995)."The Effects of Human Resource Management Practices on Productivity," NBER Working Paper , 5333.